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" The Global challenges on the development and the education of mathematics and science "

3rd ICRIEMS

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The Global Challenges on The Development and
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Faculty of Mathematics and Science
Yogyakarta State University

3rd ICRIEMS : The Global Challenges on The Development and The Education of Mathematics and Science

- Mathematics & Mathematics Education
- Physics & Physics Education
- Chemistry & Chemistry Education
- Biology & Biology Education
- Science Education

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Board of Reviewer

Preface

Bless upon God Almighty such that this proceeding on 3rd International Conference on Research, Implementation, and Education of Mathematics and Sciences (ICRIEMS) may be compiled according to the schedule provided by the organizing committee. All of the articles in this proceeding are obtained by selection process by the reviewer team and have already been presented in the Conference on 16 – 17 May 2016 in the Faculty of Mathematics and Natural Sciences, Yogyakarta State University. This proceeding comprises 9 fields, that is mathematics, mathematics education, physics, physics education, chemistry, chemistry education, biology, biology education, and science education.

The theme of this 3rd ICRIEMS is '*The Global Challenges on The Development and The Education of Mathematics and Science*'. The main articles in this conference are given by six keynote speakers, which are Prof. Allen Price, Ph.D (Emmanuel College Boston USA), Ana R. Otero, Ph.D (Emmanuel College Boston USA), Dr. Michiel Doorman (Utrecht University, Netherlands), Prof. Dr. Marsigit, M.A (Yogyakarta State University), Asst. Prof. Dr. Warakorn Limbut (Prince of Songkla University, Thailand), and Prof. Dr. Rosly Jaafar (Universiti Pendidikan Sutan Idris, Malaysia). Besides the keynote and invited speakers, there are also parallel articles that presented the latest research results in the field of mathematics and sciences, and the education. These parallel session speakers come from researchers from Indonesia and abroad.

Hopefully, this proceeding may contribute in disseminating research results and studies in the field of Mathematics and Sciences and the Education such that they are accessible by many people and useful for the Nation Building.

Yogyakarta, May 2016

The Editor Team

Forewords From The Head Of Committee

Assalamu'alaikum warahmatullahi wabarakatuh

May peace and God's blessings be upon us all

First of all, allow me to thanks to God, Allah SWT, who has been giving us blessing and mercies so we can join this conference. Ladies and Gentlemen, it is my great honor to welcome you to Indonesia, a unique country which has more than 17,000 islands, more than 1,300 ethnic groups, and more than 700 local languages, and I am also very happy to welcome you to Yogyakarta, the city of education, culture, tourism, and a miniature of Indonesia. We wish you be happy and comfortable in attending the conference in this city.

The third International Conference on Research, Implementation, and Education of Mathematics and Science (ICRIEMS 3rd) 2016 is organized by the Faculty of Mathematics and Science, State University of Yogyakarta. In this year, theme of the conference is : The Global Challenges on The Development and The Education of Mathematics and Science. This conference are dedicated to the 52nd anniversary of Yogyakarta State University and to face challenges of Asean Economic Community in 2016.

This conference facilitates academics, researchers and educators to publish and disseminate their research in the fields of pure, application and education of Science and Mathematics. Furthermore, the purposes of the conference are to establish interaction, communication, and cooperation among academics, researchers and educators at an international level.

On behalf of the committee of this conference, I would like to express our highest appreciation and gratitude to the keynote speakers, including:

1. Allen Price, Ph.D. (Associate Professor of Emmanuel College, Boston USA)
2. Ana R. Otero, Ph.D. (Emmanuel College, Boston USA)
3. Dr. L.M. (Michiel) Doorman (Associate Professor of Utrecht University, Netherland)
4. Prof. Dr. Marsigit, MA. (FMIPA, Universitas Negeri Yogyakarta)
5. Asst. Prof. Dr. Warakorn Limbut (Faculty of Science, Prince of Songkla University, Thailand)
6. Prof. Dr. Rosly Jaafar (Faculty of Physics, Universiti Pendidikan Sultan Idris, Malaysia)

Furthermore, we inform you that the papers presented in this conference are about 200 papers from 302 applicants, who come from various countries and various provinces throughout Indonesia. Therefore, I would like to give my appreciation and many thanks to the presenters and participants who have been actively involved in this seminar.

Finally, I would like to thank the committee members who have been working very hard since half a year ago to ensure the success of the conference. However, if you find any shortcomings and inconveniences in this conference, please forgive us. We would very

happy to receive your suggestions for improvement in the next conference. Thank you very much.

Wassalamu'alaikum warohmatullahi wabarakatuh.

Yogyakarta, May 2016

Dr. Warsono, M.Si.

Forewords From The Dean Of Faculty Of Mathematics And Sciences, Yogyakarta State University

Assalamu'alaikum warahmatullahi wabarakatuh. My greetings for all of you. May peace and God's blessings be upon us all.

On behalf of the Organizing Committee, first of all allow me to extend my warmest greeting and welcome to the International Conference on Research, Implementation, and Education of Mathematics and Sciences, the third to be held by the Faculty of Mathematics and Science, State University of Yogyakarta, one of the excellent and qualified education universities in Indonesia. This conference is also celebrate the 52th Anniversary of State University of Yogyakarta.

This conference proudly presents keynote speeches by six excellent academics, these are: Allen Price, Ph.D., Ana R. Otero, Ph.D., Dr. Michiel Doorman, Prof. Dr. Marsigit, MA., Asst. Prof. Dr. Warakorn Limbut, and Prof. Dr. Rosly Jaafar, and around 200 regular speakers.

The advancement of a nation will be achieved if education becomes a priority and firmly supported by the development of technology. Furthermore, the development of technology could be obtained if it is supported by the improvement of basic knowledge such as mathematics, physics, chemistry, and biology. The empowerment of this fundamental knowledge may be achieved by conducting research which is then implemented in developing the technology and the learning process in schools and universities.

This international conference is aimed to gather researchers, educators, policy makers, and practitioners to share their critical thinking and research outcomes. Moreover, through this conference it is expected that we keep updated with new knowledge upon recent innovative issues and findings on the development and the education of mathematics and science, which is in accord with the theme of the conference this year. All material of the conference which are compiled in the abstract book and proceedings can be useful for our reference in the near future.

This conference will be far from success and could not be accomplished without the support from various parties. So let me extend my deepest gratitude and highest appreciation to all committee members who have done an excellent job in organizing this conference. I would also like to thank each of the participants for attending our conference and bringing with you your expertise to our gathering. Should you find any inconveniences and shortcomings, please accept our sincere apologies.

To conclude, let me wish you fruitful discussion and a very pleasant stay in Yogyakarta.

Wa'alaikumsalam warahmatullahi wabarakatuh

Yogyakarta, May 2016
Dean Faculty of Mathematics and Science
Yogyakarta State University

Dr. Hartono, M.Si.

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PE – 05

Critical Thinking Skills Profile of High School Students In Learning Science-Physics

KHAERUDDIN[1], MOHAMMAD NUR [2], WASIS [3]

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Abstract-This study aims to describe Critical Thinking Skills high school students in the city of Makassar. To achieve this goal, the researchers conducted an analysis of student test results of 200 people scattered in six schools in the city of Makassar. The results of the quantitative descriptive analysis of the data found that the average value of students doing the interpretation, analysis, and inference in a row by 1.53, 1.15, and 1.52. This value is still very low when compared with the maximum value that may be obtained by students, that is equal to 10.00. This shows that the critical thinking skills of high school students are still very low. One fact Competency Standards science subjects-Physics is demonstrating the ability to think logically, critically, and creatively with the guidance of teachers and demonstrate the ability to solve simple problems in daily life. In fact, according to Michael Scriven stated that the main task of education is to train students and or students to think critically because of the demands of work in the global economy, the survival of a democratic and personal decisions and decisions in an increasingly complex society needs people who can think well and make judgments good. Therefore, the need for teachers in the learning device scenario such as: driving question or problem, authentic Investigation: Science Processes.

Keywords: Profiles, Critical Thinking Skills, interpretation, analysis, inference.

I. INTRODUCTION

Critical thinking skills are skills that must be nourished for students and university students to be able to compete in the 21st century, but to develop the thinking skills including critical thinking skills lies in the skills of the students (National Education Standards, 2006). According Karamustafaoglu (2011), the development of science process skills enable students to construct and solve problems and think critically. This possibility can occur because the components of critical thinking is largely a component of science process skills such as designing experiments, testing hypotheses, hypothesizing, predicting, inferring, classifying, measuring, observing (Hassard, J., 2005, p.332). Thus, if students' science processes skill developed, critical thinking skill will evolve Too. One of the Competency Standards (SKL) in the science subjects demonstrated the ability to think logically, critically, and creatively with the guidance of teachers and showing the ability to solve simple problems in daily life. This means that after following the science lessons, students are expected to have the ability to think critically. However, the background of this study have stated that one of the indicators of non-optimal ability to think, work and behave and communicate science students is poor science process skills of students. Though science process skills can spur the development of a variety of thinking skills of students. From this brief description indicates that students' critical thinking skills should be developed through learning.

According to Michael Scriven, the main task of education is to train students and university students to think critically because of the demands of work in the global economy, the survival of a democratic and personal decision in the complex society needs people who can think well and make good judgments (Jennifer. H, 1998). Therefore, critical thinking is an essential tool that is taught to students and or students to succeed in a world that is increasingly complex and rapidly changing. Brookfield encourages educators to take a critical reflective stance toward teaching and helping students to face their world or environment with compassion, understanding, and justice. When teachers practice critical thinking, it encourages the creation of a democratic classroom (Ozkahraman Yildirim S & B: 2011). Paul believes that critical thinking is an important basis for education to adapt the demands of the 21st century,

personally and socially. In view of the rapidly changing world and global reality there is a critical need for individuals to develop skills and abilities that enable them to adapt and respond the demands of the 21st century.

Based on Some experts' opinion regarding the concept of critical thinking skills, the author can state that critical thinking skills are thinking skills that involve high-level cognitive processes, namely interpretation, analysis, evaluation, and inference through scientific procedures in order to solve the problem (Dewey, 1991; Kurfiss, 1991; Burden and Byrd, 2007; Beyer, 2008; Screven, Paul and Angelo, 2008; Rudinow and Barry, 2008). From the definition above, the authors make as an indicator of critical thinking skills in this study is the interpretation, analysis, and inference.

II. RESEARCH METHOD

This study was a descriptive study to reveal the critical thinking skills of high school students. Giving critical thinking skill test to the students of senior high school in Makassar city with the total number of students are 200 persons. Critical Thinking Ability Test (CTAT) of Physics is structured with the following steps: (i) Adapting questions from physics book: Principle and Problems by Zitzewitz, P., W., et. al. The questions which were adapted are the questions that match with the indicators of critical thinking skills, they are; **interpretation, analysis, inference**, (ii) Giving to some colleagues that have background of Bachelor of education, master degree, and doctoral program, for validating readability of physics critical thinking skills question. The technique of data collecting were Critical Thinking Ability Test (CTAT) of physics to measure students' critical thinking skill include high level cognitive processes, namely interpretation, analysis and inference through scientific procedures in order to solve the problem. While the data analysis technique used quantitative descriptive techniques.

III. RESULTS AND DISCUSSION

A. Results

This study aims to describe critical thinking skills of students at several high schools in Makassar. The detailed results of critical thinking skills such as Table 1 below.

TABLE 1. CRITICAL THINKING SKILL'S TEST HIGH SCHOOL STUDENTS

School Name	**Indicator Critical Thinking Skills**		
	Interpretation	*Analysis*	*Inference*
SMAN 2 Makassar	*1.50*	*0.08*	*0.28*
SMAN 9 Makassar	*0.81*	*0.14*	*0.86*
SMAN 10 Makassar	*1.16*	*0.76*	*0.88*
SMAN 14 Makassar	*0.90*	*0.71*	*2.00*
SMAN 15 Makassar	*1.25*	*0.47*	*1.56*
SMAN 17 Makassar	*3.56*	*4.75*	*3.56*
Number	*9.18*	*6.92*	*9.13*
The average value/ indicator	*1.53*	*1.15*	*1.52*

Remarks: maximum value = 10

Table 2 illustrates that the average critical thinking skills include **interpretations** of 1.53, the **analysis** of 1.15, and the **inference** of 1.52. These values indicate that critical thinking skills are still low when compared with the maximum possible value is achieved by the students, that is equal to the value of 10.00. These results, also happens to students of higher education, namely students' critical thinking skills are still low. Results of Critical Thinking Ability Test (CTAT) of students in detail can be seen in Table 2 below.

TABLE 2. RESULTS OF STUDENT CRITICAL THINKING TEST

Department & Class	Indicator Critical Thinking Skills		
	Interpretation	*Analysis*	*Inference*
Physics Education	*1.50*	*1.91*	*2.20*
Physics Education International Class A	*1.51*	*1.77*	*2.42*
Physics Education International Class B	*1.39*	*0.69*	*0.74*
Number	*4.39*	*4.38*	*5.36*
The average value / indicator	*1.46*	*1.46*	*1.79*

Remarks: maximum value = 10

Table 2 illustrates that the average of students' critical thinking skills include interpretation of 1.46, analysis of 1.46, and the inference of 1.79.

B. Discussion

The general objective of this study is to describe the critical thinking skills of high school students in Makassar. Descriptive analysis of the data found that the average value of students doing the interpretation, analysis, and inference in a row by 1.53, 1.15, and 1.52 (Table 1). This value is still very low when compared with the maximum value that may be obtained by students, that is equal to 10.00. This means that the critical thinking skills of high school students are still very low.

In the Journal "Higher Education Research & Development" (2011) states that to make students as critical thinkers in the learning takes five terms, namely:

(i) the student has the skills and abilities such as how to know, how to evaluate or analyze (Siegel, 1988; Facione , 2006; Khaeruddin, 2013);
(ii) prepare and prepare learning engages students in critical thinking such as reasoning and analysis (Siegel, 1988; Perkins, Jay & Tishman, 1993; Ennis, 1996; Khaeruddin, 2013),
(iii) Understand the involvement in learning and understanding that thinking the construction and evaluation of critical reasoning, not show the correct answer or just opinion (Perry, 1990; Kuhn, 1999; Khaeruddin, 2013);
(iv) Work and meet the criteria to take into account the success of critical thinking (Bailin, Et al., 1999);
(v) The students understand the material (McPeck, 1981).

Based on some opinions in the Journal "Higher Education Research & Development" above, the results of this study show fact that the lack of critical thinking skills of students resulted by the teacher in the learning process, the teacher seldom stimulate the development of science process skills of students and student critics' skills such as: (i) books that are used less stimulating of critical thinking, creative, and innovative, problem-solving; (iii) use worksheets that do not stimulate the development of science process skills; (iv) the learning objectives in a lesson plan does not specifically oriented toward science process skills. The formulation of learning objectives only cognitive-oriented products, but no true purpose which leads to cognitive processes, namely the higher level thinking; (v) test given to students is still largely oriented cognitive products. This is contrary to the opinion of some experts associated with the requirement to make the students as critical thinkers. It is also proved that the learning results of the test device oriented to the development of critical thinking skills. Teachers were confused in teaching using worksheets that can develop students' ability. In fact, they ask for some questions about "what is the manipulated variable, the response variable, the control variable, why there is no procedure works" The results of this trial reinforces that the worksheets used in the learning process has not stimulated the development of science process skills. That is an important aspect in building scientific literacy of students, it didn't works at all, it was not optimal, i.e. the understanding of the terms in the habits and communicate science in science learning. The way students learn and teachers' ability to recognize the students' potential is not maximized.

In fact, the ability of the teachers to recognize students' potential will facilitate preparing, formulating and implementing the curriculum. The curriculum is then used as a tool to assess the level of

achievement of student learning. To support the implementation of the science curriculum is needed, instructional materials that can develop science process skills. Therefore, the existence of teaching materials is crucial in the success of learning according to the learning objectives. Teaching materials can bridge the experience with the knowledge of students, the adequacy concept, depth, as well as its application in the context of students' daily life.

Therefore, science teaching materials should be drawn up which provides opportunities for students to develop:

(i) The process skills which include the ability to observe, comparing and contrasting, classifying, measuring, communicating, and the skill of higher level , as predicted , apply concepts, and communicate;
(ii) The ability inquiry;
(iii) The ability to think;
(iv) The ability of scientific literacy in order to understand the science terms (Toharudin 2011: 205).

Thus, science teachers should be good at sorting and selecting strategies according to the characteristics of the science subjects. Learning Science-physics must execute oriented science process skills to cultivate the ability to think, work and behave and communicate scientific as one of the important skills that must be possessed by the student. This is because scientific procedures requiring interpretation in order to solve problems, analysis, and inference, whereas the third indicator is the critical thinking skills that involve high-level cognitive processes (Dewey, 1991; Kurfiss, 1991; Burden and Byrd, 2007; Beyer 2008 ; Screven, Paul and Angelo, 2008; Rudinow and Barry, 2008).

Even the power of learning science in building students 'critical thinking skills lies in the ability to process skills (Science Processes Skills) which stimulate the development of a variety of students' thinking skills and it is the demands of the curriculum 2013 According Karamustafaoglu (2011), the development of science process skills enable students construct and finish problems and think critically. This possibility can occur because the components of critical thinking is largely a component of science process skills such as designing experiments, testing hypotheses, hypothesizing, predicting, inferring, classifying, measuring, observing (Hassard, J., 2005, p.332). Thus, if students' science processes skill developed, critical thinking skill will evolve too. The low critical thinking skills of students, it also happens to a university student. This is shown by the average student critical thinking skills include interpretation of 1.46, analysis of 1.46, and the inference of 1.79 (Table 2). The low critical thinking skills of university students is because they are still getting used to the pattern of learning at the high school level, given the critical thinking skills test is given to students of the second semester.

In addition, the university students mostly from districts in South Sulawesi , learning pattern is approximately same to 6 schools in Makassar as the place to study, even if the terms of the school is below the level of the school in Makassar. However, generally, critical thinking skills of university students are higher than the high school students. This allows the case because in a period of 6 months in the program study physical education, students of State University of Makassar have been doing practicum oriented to Science Skill Processes. But the difference between university students' critical thinking skills and students were not significant. This reinforces the statement Nur (1998: 22) who says that to develop aspects of students' cognitive skills, not an easy job, it takes a long time to build and develop process skills. O'flahavan and Stein (Brunning, 1995) argues that the skills should be done over and over again , whereas according to the Burden and Byrd categorize critical thinking as a thinking activity that requires a high level of cognitive skills (Irani, Rudd, Gallo, Rickets, Friedel, & Rhoades, 2007). Therefore giving an opportunity to students and university students to think critically is not enough, without realization. So students and university students should use the opportunity continuously.

IV. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of research and discussion, it can be concluded that: Critical thinking skills of high school students in Makassar is still very low when compared with the maximum value of 10.00 which may be obtained by students, namely the interpretation of 1.53, analysis of 1.15, and the inference of 1.52. To cultivate students' critical thinking skills, necessary learning process in the classroom such as: driving question or problem, authentic Investigation: Science Processes Skills, collaboration, and discussion.

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